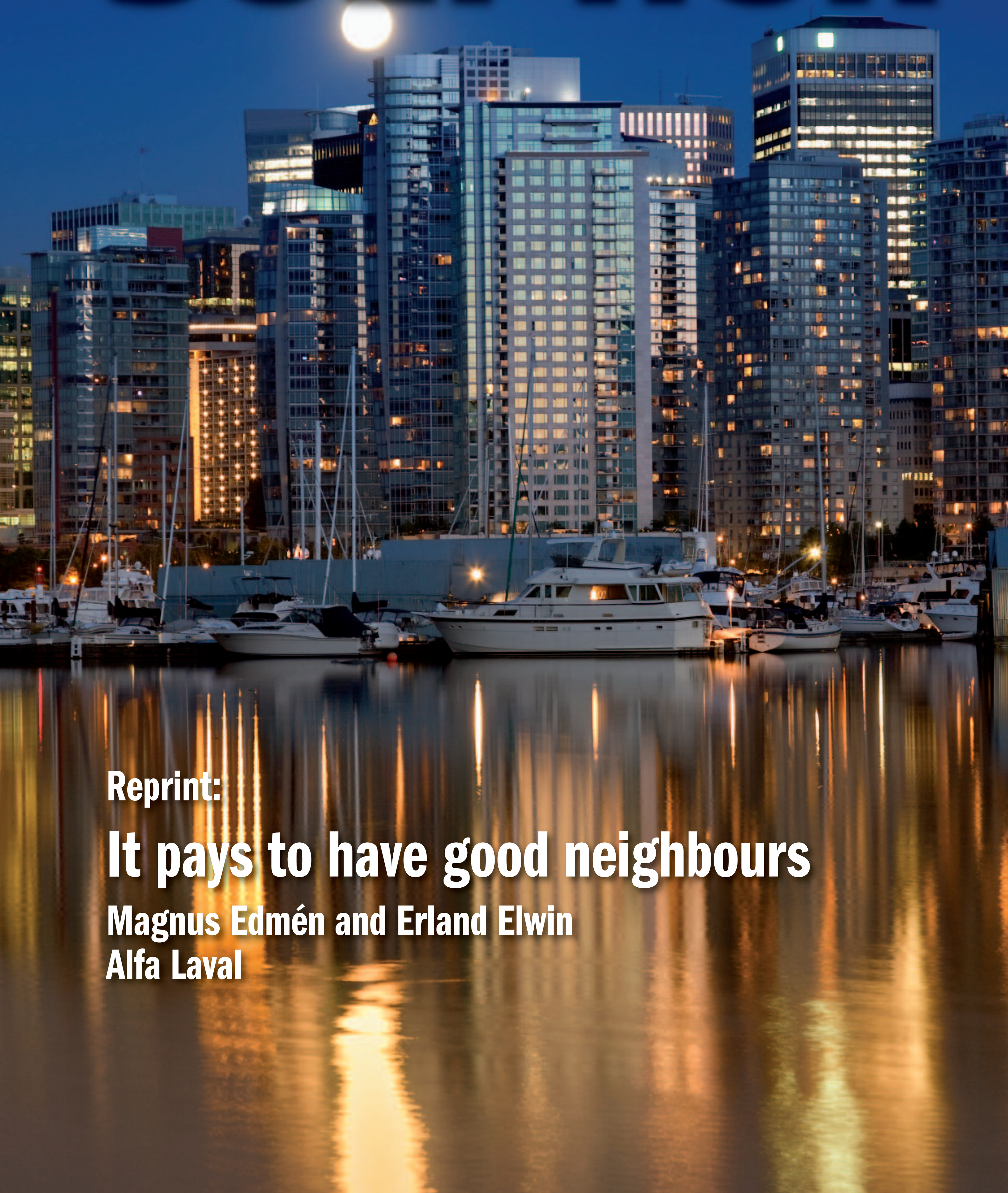
Number 324

September | October 2009

# SULPHUR



Reprint:

## It pays to have good neighbours

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# It pays to have good neighbours

By quantifying the payback time of the investment, this article shows that low grade heat recovery using plate heat exchanger technology can be very profitable for a sulphuric acid plant. What you need, say **Magnus Edmén** and **Erland Elwin** of Alfa Laval, is a large, low temperature energy consumer, such as a zinc or copper plant, nearby.

A 1,000 t/d sulphuric acid plant releases around 65 MW of heat. Around one-third of the heat is released from absorption and drying towers at low temperatures. Most plants waste this low temperature heat to cooling towers, rivers or the air. In order to make recovery of low temperature heat profitable, a large low temperature energy consumer nearby is needed.

A simplified flow chart of the considered low temperature heat recovery system is shown in Fig. 1.

The heat released from the acid tower heats a water loop that delivers the heat to an external heat consumer, such as process steps in zinc or copper production.

The potential for saving energy is to be found where steam can be replaced by hot water generated in the sulphuric acid plant. Two examples of this are heating of rich electrolyte in copper production and heating of zinc sulphate solution in zinc production.

Fig 1: **Principles of low grade heat recovery**

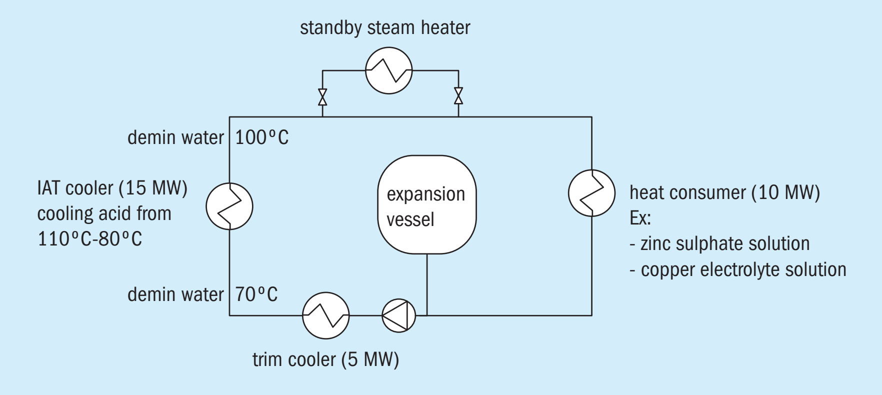



Fig 2: **Overview of copper ore processing**

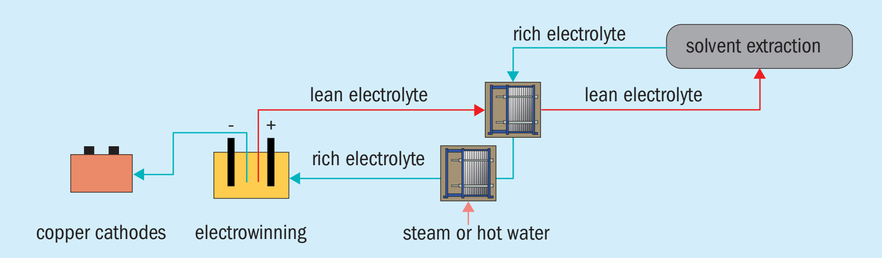
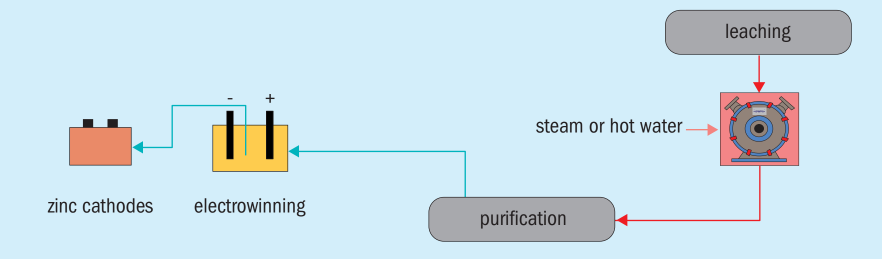



Fig 3: **Overview of zinc ore processing**




## Heating rich electrolyte in copper production

The electrowinning cell normally accounts for the most energy consuming process in a copper plant[1]. Here, steam is used to heat rich electrolyte to its final temperature before entering the electrowinning cell. Using low grade heat from the sulphuric acid plant to replace this steam offers considerable potential for reducing the net consumption of energy in the plant. Figure 2 shows an overview of copper ore processing.

## Heating zinc sulphate solution

In the leaching section of a zinc plant, the zinc ore is mixed with sulphuric acid. The sulphuric acid dissolves the zinc in the ore and form a zinc sulphate solution. The solution is heated with steam in a heat exchanger before the purification and electrowinning steps[2]. To reduce the net consumption of energy, steam can often be replaced by hot water generated from a sulphuric acid plant. Figure 3 shows an overview of zinc ore processing.

## Calculation and assumptions

The aim of this article is to estimate the profitability of low grade heat recovery investments. It is therefore important to describe how costs and profits have been quantified.

It is assumed that the system is replacing existing acid coolers as well as heat exchangers in the mineral plants. It is also assumed that cooling water is readily available at the acid plant.

### Heat exchanger total installation cost

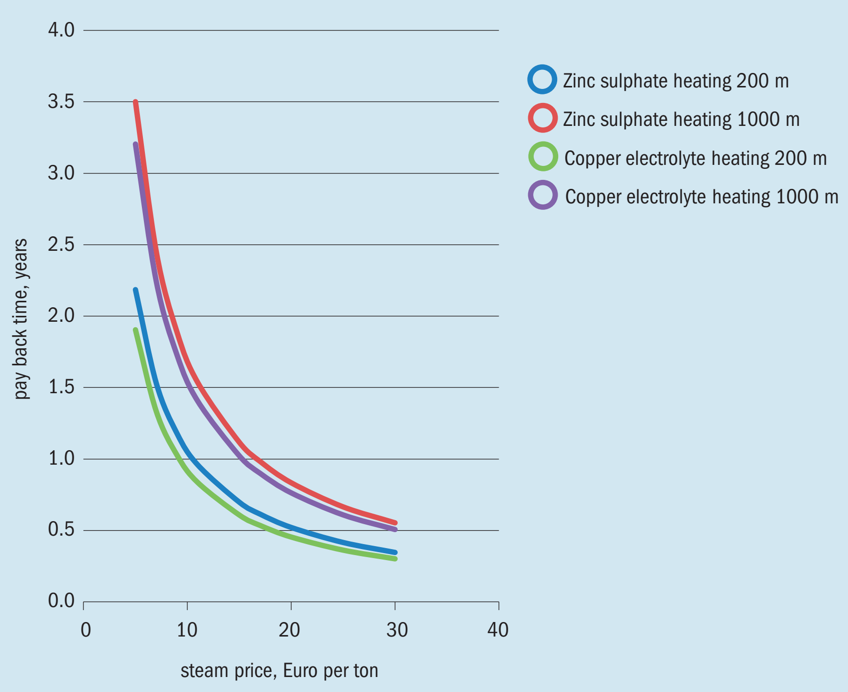
A common rule of thumb for estimating the total installation cost for heat exchangers is to use a factor 3 from the unit cost. Materials used in sulphuric acid coolers, as well as other equipment in zinc and copper processes need to be of corrosion resistant alloys. These alloys can be up to six times more expensive than stainless steel, which suggests the factor should be lower for this case, as engineering and installation cost do not escalate that much due to the use of a more expensive alloy in the heat exchanger. The total installation cost of heat exchangers is therefore estimated at 1.5 times the cost of the heat exchangers.

Temperature approach is an important factor that affects heat transfer surface area. The acid cooler is designed for 15 MW acid cooling from 110°C-80°C by using hot water from 70°C-100°C. Semi-welded plate heat exchanger technology in Hastelloy D205™ plate material is selected for this purpose for all cases.

For the copper electrolyte heating case, gasketed plate heat exchangers in stainless steel 316 have been used. Copper electrolyte is heated from 50°C-65°C by hot water from the acid plant.

Spiral heat exchangers in 904L material are used as zinc sulphate solution heaters. Zinc sulphate solution is heated from 55°C to 85°C by hot water from the acid plant.

Fig 4: **Profitability of low grade heat recovery**




### Distance between plants

A study was made by Lund University and Alfa Laval (Iwarsson, 2008) where the total cost of connecting a sulphuric acid plant to a district heating grid was estimated. Total project cost per metre of pipe was concluded to be approximately 600 Euro per metre, with an estimated heat loss of approximately 60W/m of pipe[3]. As the pipe sizes needed for our calculations are similar to the ones considered in Iwarsson's study, these values have been considered in our calculations

Consumption of electricity in the pumps has been estimated at 100 kW for the case with 1,000 m distance between the plants, contributing with an increased operating cost of 50,000 Euro per year.

### Engineering, vessels, pumps, instrumentation, etc.

For costs of engineering, comissioning, erection, instrumentation and equipment other than heat exchangers, the cost estimations from Iwarsson's (2008) report[4] have been used as the size of the system considered in this article is similar to the one considered by Iwarsson.

### Quantification of energy savings

As steam is the main carrier of energy in most plants, the price of a ton of steam is often well known. The steam price in Euro/t is therefore used to quantify energy savings. As a benchmark, a cost of 20-25 Euro/t of steam is not uncommon in European industrial plants.

In all cases it is assumed that the recovered heat is replacing 10 MW of steam coming from a boiler with 80% efficiency.

## Conclusions

The results of the payback analysis are shown in Fig. 4.

Low grade heat recovery using plate heat exchanger technology can be very profitable. At steam prices of 10 Euro/t and long distances between the plants the payback period can still be less than two years. At higher energy prices and shorter distances between plants, profitability rapidly increases.

## References


1. Lossin, Adalbert, Copper; Ullmann's Encyclopedia of Industrial Chemistry, 2005.
2. Graf, Günter G., Zinc; Ullmann's Encyclopedia of Industrial Chemistry, 2005.
3. Logstor calculator, http://calc.logstor.com/, 2009-06-15.
4. Iwarsson Daniel, "Evaluation of different alternatives for recovering low grade waste heat from the sulphuric acid process", Masters thesis, Lund University, 2008.

**Reprint from Sulphur magazine Sep/Oct 2009**
PPI00377 0909